CMWR 2008 STUDENT FELLOW AWARDEE

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TITLE: Pumping Optimization of Coastal Aquifers based on Evolutionary Annealing-Simplex Scheme and Artificial Neural Networks

ABSTRACT:

Management of coastal aquifers involves complex evaluations using computationally intensive numerical models such as SEAWAT. When these models are integrated into an optimization framework based on global optimization algorithms (simulated annealing, Genetic algorithms, etc.), the overall computational time may be exceptionally large. The present study develops an alternative methodology based on a heuristic Evolutionary Annealing-Simplex Scheme (EASS), where a generalized downhill simplex methodology is coupled with a simulated annealing procedure to perform the optimization search. In order to reduce the computational burden, dispersion in the costal aquifer is simulated using Artificial Neural Networks and training is carried out simultaneously with optimization in an iterative manner. As optimization progresses, the weights and biases of the network are adjusted so that the network performs well in the current search space. Combining EASS with ANN, results in a near-optimum solution using a relatively small number of function evaluations of the numerical model (SEAWAT).

In cases with many decision variables, training of a network may be computationally intensive and a division of the master network into smaller sub-networks is used to train the network. Using this approach, it is possible to train only parts of the networks that do not perform well.

The proposed EASS-ANN scheme is evaluated in three applications and compared to three global optimization algorithms (Genetic Algorithm Simulated annealing, threshold acceptance). Two hypothetical applications with 4 and 13 decision variables respectively were useful for performing sensitivity analysis on crucial parameters and configuring the algorithm (initial population, training schedule, radius of influence and neural network structure). The optimum configurations were applied in a real application in the coastal aquifer of the Greek island of Santorini. The results show that the proposed EASS-ANN scheme performs equally well as other well known global optimization techniques and requires significantly less computer time.